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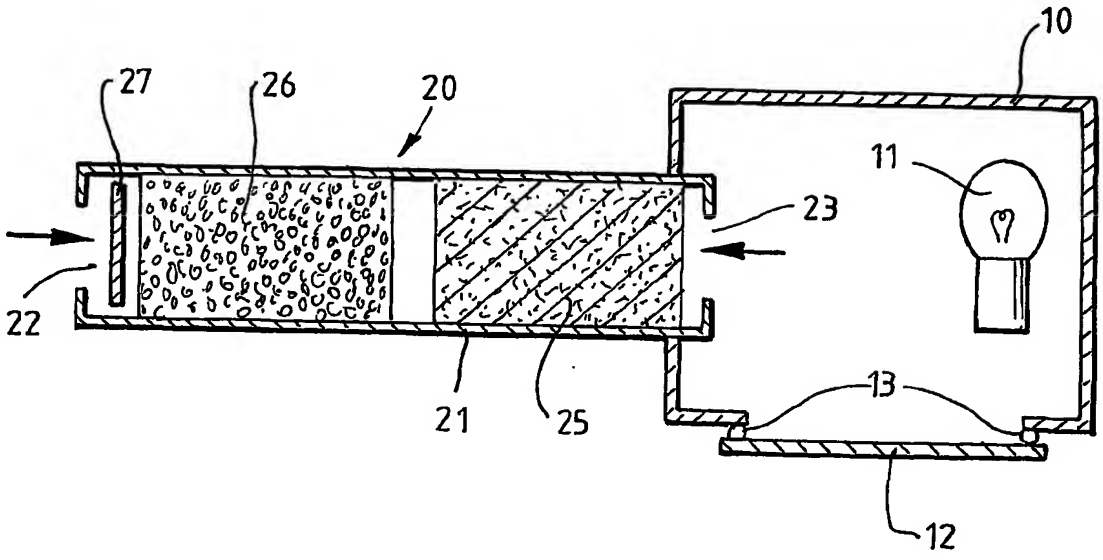
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A FILTER



(57) Abstract: Electrical equipment comprising a sealed chamber in which an electrical appliance is housed, and a multi-stage breather filter attached to the sealed chamber whereby in use heat generated by the electrical appliance causes air flow through the filter and also dries moisture collected by the filter.

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A FILTER

FIELD OF THE INVENTION

This invention relates to a filter for use with ventilated electrical equipment.

BACKGROUND OF THE INVENTION

Ventilated electrical equipment, especially lighting, suffers from the entry of moisture, dirt and corrosive chemicals into what appear to be sealed areas of the equipment. This entry causes deterioration and ultimate breakdown of the equipment.

The root cause of the entry of potentially harmful fluids/contaminants is primarily the result of the expansion and contraction of air within the electrical equipment caused by changes in temperature.

The process is typically illustrated with reference to figure 1 which is a standard light fitting. It is however understood the process is equally applicable to many other types of electrical equipment such as motors, transformers, junction boxes and cables.

Figure 1 is a schematic illustration of a conventionally sealed lighting system in which enclosure E contains a light bulb L and a cover C closes off the enclosure via a peripheral gasket or seal S. The air immediately surrounding the lighting equipment is indicted as SA the ambient air is indicated as A.

Four steps make up the process that can ultimately result in a failure of the light.

Step 1 - At installation the light is connected and closed up, trapping air inside the enclosure. The air

is now at ambient temperature and pressure.

Step 2 - The lamp is energised and starts to radiate 80% or more energy as heat into the trapped air, heating the air quite effectively. The increased temperature increases the internal pressure.

Step 3 - The pressurised internal air now finds ways to escape into the ambient air, which is at a lower pressure and temperature than the air inside the light. This escape is notwithstanding the presence of seals. The escape of the pressurised internal air takes place until the internal pressure is equal to the ambient pressure.

Step 4 - The lamp is then switched off, allowing the internal air to cool and the pressure decreases which reverses the process in step three and causes entry of air into the enclosure.

This process is exasperated by some still further less obvious activity, such as the air in the immediate vicinity of the light is warmed by radiated heat from the light. This heating would initially lower the relative humidity of the air immediately surrounding the light but is quickly balanced by diffusion from the ambient air, effectively creating a pocket of warm air at the same relative humidity as the ambient air. This warm air enters the enclosure when the light is switched off. When the light reaches ambient temperature the excess moisture trapped inside cannot diffuse into the external air but condenses onto some surface like the lens of the light.

When the lamp is energised again and step 1 starts the heated air expands and leaves the light much faster than the condensate can evaporate. Thus most of the collected moisture remains inside the light. The internal pressure stabilises, the internal air warms up

and the remaining condensate evaporates into it. When the lamp is later switched off, another load of slightly more humid air enters the light. This soon forms a heavy deposit of condensate collecting on the inside of the enclosure. The entry of air also has the habit of drawing in fine dust and any other corrosive materials that might be present in the air. Electrical faults occur when the condensate or carbon deposits create alternative circuits. In acid or salt laced air the conductivity of the trapped condensate may be several orders higher than fresh water, thus further contributing to breakdown of the electrical system.

The cyclic system described above concentrates the contaminates in the condensate and while the lamp supplies heat that speeds up the corrosive action compared with the same material at lower concentration and temperatures. In the event that a light is covered in a layer of moisture from dew or rain, the normally insignificant contribution of capillary action is increased significantly by the suction of a cooling light.

Although seals are very effective to stop particulate and liquids entering an enclosure, this effectiveness is particularly increased if they can be compressed into seats. This is not always possible particularly where the equipment has to be readily dismantled for service.

It is these issues that have brought about the present invention.

SUMMARY OF THE INVENTION

According to the present invention an electrical equipment comprises a sealed chamber in which an electrical appliance is housed, and a multi-stage breather filter attached to the sealed chamber whereby in use heat

generated by the electrical appliance causes air flow through the filter and also dries moisture collected by the filter.

Preferably, the multi-stage filter comprises a filter housing defining an airflow passageway, the passageway including successive filter stages defined by

a) a porous membrane
b) activated carbon, and
c) silica gel.

Preferably the passageway defines an air inlet at one end and an outlet at the other, the outlet being coupled to the electrical equipment.

DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which Figure 2 which is a schematic illustration of a light fitting incorporating a filter in accordance with an embodiment of the present invention, and Figure 3 is a sectional view of a driving light incorporating a filter of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiment as illustrated in Figure 2 is a schematic illustration of a light fitting that comprises a rectangular enclosure 10 that contains a light bulb 11. The enclosure 10 is sealed by an external cover 12 via a peripheral seal or gasket 13. A filter 20 in the form of a cascade filter is adapted to be coupled to the enclosure. The cascade filter comprises a cylindrical housing 21 open at both ends 22 and 23 to define a fluid passageway. One end 23 is in fluid communication with the enclosure 10. The cylindrical housing 21 includes a block 25 of silica gel granules adjacent the end 23 that is attached to the housing 11. The block 25 of gel is

positioned slightly spaced apart from a block 26 of activated carbon granules. A membrane barrier 27 is positioned on top of the activated carbon block 26 in close proximity to the outlet 22 of the housing 21. The filter 20 is designed so that air can flow in and out of the filter as described below.

The filter operates in the following manner. Initially the light goes through the three steps described in the introduction of the specification. Step 4 starts when the lamp 11 is switched off and the internal air starts to cool and the pressure decreases whereby drawing air into the enclosure 10 through the cascade filter 20. The air first passes through the micro-porous membrane 27 that is fabricated from PTFE or other such material. This membrane 27 filters out particulate matter to a predetermined size, typically to sub-micron level. The membrane also forms a vapour barrier that stops water entering. This can include pressurised water and detergents from high pressure cleaners.

The air then passes through the activated carbon block 26 that strips most corrosive chemicals and free radical oxidants through adsorption. After leaving the activated carbon block 26 the air passes through silica gel 25 that dehydrates the air further. The air then enters the enclosure 10 at ambient temperature and pressure containing no moisture or corrosive agents. When the light is switched on and starts to radiate 80% or more energy as heat into the trapped air, the air heats up effectively increasing its temperature and pressure. The pressurised internal air now exits the filter 20 until the internal pressure is equal to the ambient pressure. When the lamp is switched off the operation is repeated. In this manner the cyclic turning on and off of the lamp does not draw moisture or corrosive elements into the enclosure.

The filter 20 effectively cleans the air mechanically and chemically to a level that prevents deterioration of the optical surface through corrosion and contamination. This ensures that the light effectively retains the light output and distribution to which it was originally designed, whilst extending its operational life significantly. Because the exiting air is hot and at a higher pressure than the ambient air, it dries out the silica gel 25 on the way out removing the moisture to the atmosphere. Thus all the benefits of higher volumetric moisture capacity of warm air accrues to the recycling system. The PTFE membrane 27 is self cleaning because dirt does not stick to it.

Whilst Figure 2 is merely a schematic illustration of the introduction of the filter it will be understood that electrical equipment would be designed to incorporate the filter at the design phase of the product.

Figure 3 is a cross sectional view of a driving light for a vehicle that incorporates a breather filter 20 of the kind described above. The driving light 30 shown in figure 3 includes a lens 31 that is in sealed attachment to a parabolic reflector 32 that in turn houses an appropriate light bulb 33 contained in the optical cavity 35. The reflector 32 lens 31 and light bulb 33 are all supported by a housing 34 that surrounds the rear of the reflector and includes a mounting bracket 39. The housing 34 is also coupled to an electrical lead 36 that is wired to the rear of the light bulb through a sealed cap 37 at the rear of the optical cavity 35. The housing 34 includes an air cavity 38 to the rear of light that is in fluid communication with the optical cavity 35.

Interposed in series with the optical cavity 35 and the air cavity 38 is the multi-stage filter 20. The

air cavity 38 is in direct communication with the external atmosphere. The multi-stage filter 20 comprises microporous filter mediums 40 and 41 at the air entry side and optical cavity 35 side of the filter. Between the two microporous filters is a cavity 42 filled with deactivated carbon on the optical cavity side and a cavity 43 filled with silica gel on the air entry side of the filter. The wavy line on Figure 3 indicates the air path in and out of the optical cavity 35 via the multi-staged filter 20.

In all cases the filter is designed in the position whereby the majority of the air flows through the low resistance filter with only a small proportion passing through the high resistant paths that would be represented by seals and gaskets. This simple measure reduces the effect of seal imperfection and maintains the initial effectiveness over the life of the product. Because there is effectively no pressure differential across the seals, the stress is reduced eliminating air transportation and capillary action. Thus with correct implementation it is considered that the filter will extend the life of the product, the seals and the enclosure without additionally adding to the production costs. The use of a filter of the kind described above provides ventilation for enclosures that will solve the vast majority of corrosion and fouling problems that occur. This sort of equipment is particularly useful where the equipment is continually used in dirty or corrosive environments like mines or petrochemical plants. It is further understood that the filter will be used with a whole variety of electrical equipment not just lighting systems.

Although the preferred embodiment utilises a three stage filter that incorporates a microporous membrane usually fabricated from PTFE, an absorption material usually activated carbon and a dehydrating element silica gel, it is understood that a wide variety

of filtration materials can be used for the purposes described above. Suitable filter media should have a collection efficiency over a wide range of particle sizes. There are many adequate filter media that have adequate flow and resistant properties. Typical medias include microfiberglass media, high efficiency electret materials, and membrane materials such as, but not limited to, expanded polytetrafluoroethylene membrane, polypropylene membrane, nylon membrane, polycarbonate and polyester membranes, mixed-esters of cellulose membrane, polyvinyl chloride membrane, cellulose triacetate membrane, and thin film composite membranes and/or laminates thereof.

The most preferred filtering layer is expanded polytetrafluoroethylene (PTFE) because of its good filtration performance, conformability to cover absorbent layers, and cleanliness.

Examples of suitable absorbent materials include: physisorbers (e.g. silica gel, activated carbon, activated alumina, molecular sieves, etc.); chemisorbers (e.g. potassium permanganate, potassium carbonate, potassium iodide, calcium carbonate, calcium sulfate, sodium carbonate, sodium hydroxide, calcium hydroxide, powered metals or other reactants for scavenging gas phase contaminants); ion exchange materials; catalytic fillers; as well as mixtures of these materials.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Electrical equipment comprising a sealed chamber in which an electrical appliance is housed, and a multi-stage breather filter attached to the sealed chamber whereby in use heat generated by the electrical appliance causes air flow through the filter and also dries moisture collected by the filter.

2. The electrical equipment according to claim 1 wherein the multi-stage filter comprises a filter housing defining an airflow passageway, the passageway including successive filter stages defined by

a) a porous membrane

b) activated carbon, and

c) silica gel.

3. The electrical equipment according to claim 2 wherein the passageway defines an air inlet at one end and an outlet at the other, the outlet being coupled to the electrical equipment.

4. The electrical equipment according to any one of claims 1 to 3 wherein the electrical appliance is a light element.

5. The electrical equipment according to any one of claims 2 to 4 wherein the porous membrane is fabricated from PTFE.

6. The electrical equipment according to claim 5 wherein the porous membrane is positioned adjacent the air inlet with the silica gel being positioned adjacent the outlet of the filter.

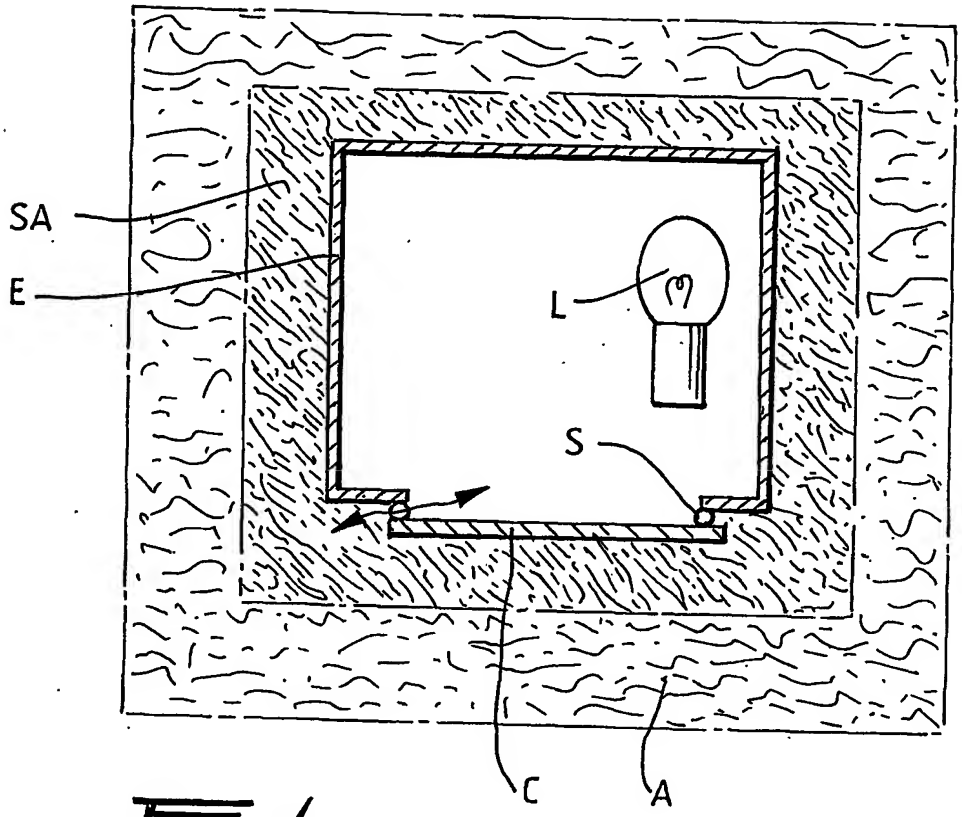

FIG. 1.

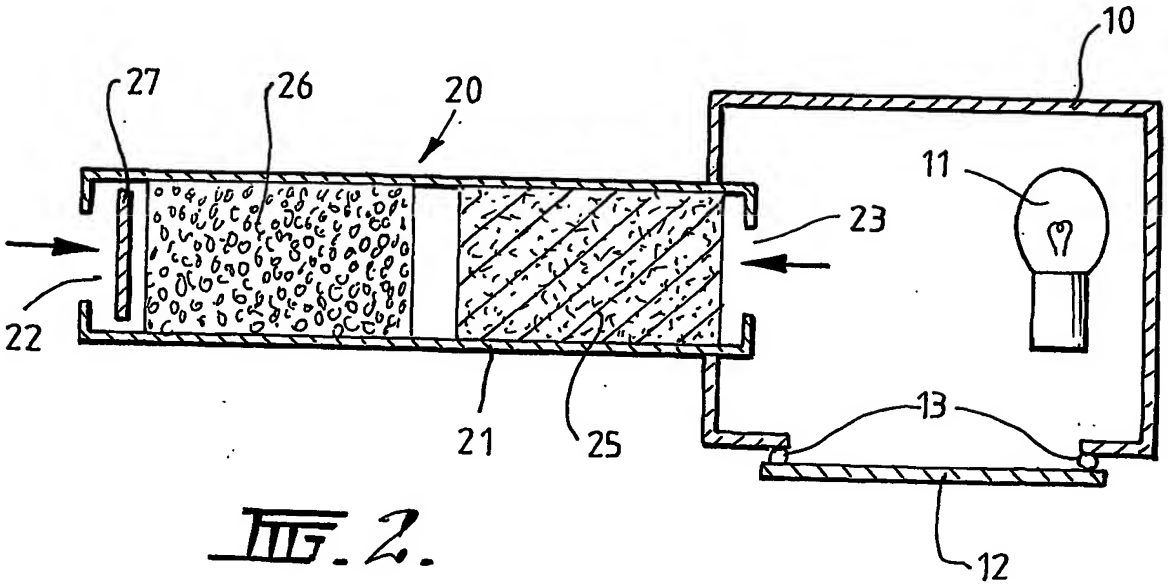

FIG. 2.

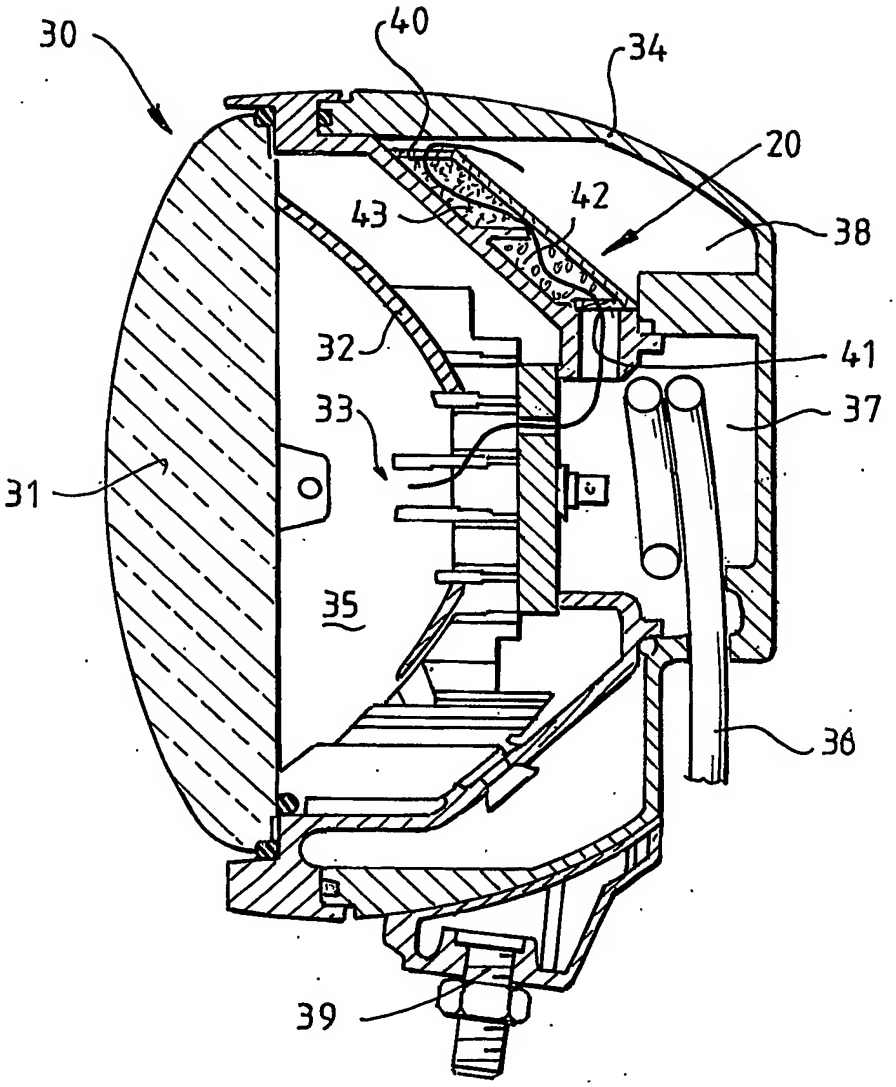

FIG. 3.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2003/001726

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: B01D 35/02, 53/26, H05K 7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B01D 35/02, 53/26, H05K 7/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI filter+ and (applianc+ or motor+ or transform+ or junction box+ or terminal box+) and (activated carbon and silica gel) and membran+ and electric+;
USPTO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6395073 B (Dauber) 28 May 2002 See whole document	1-6
X	US 6238467 B (Azarian et al.) 29 May 2001 See whole document	1-6
X	US 6296691 B (Gidumal) 2 October 2001 See abstract and figure 6	1-6

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 January 2004	- 9 FEB 2004
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer JOHN DEUIS Telephone No : (02) 6283 2146

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2003/001726

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6593525 B (Vanderhoof et al.) 15 July 2003	
A	US 6108202 A (Sumida) 22 August 2000	
A	US 4129743 A (Lohsl) 12 December 1978	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2003/001726

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	6395073	AU	69261/00	CA	2381130	EP	1218090
		WO	0114041				
US	6238467	AU	76082/00	EP	1222661	WO	0122422
US	6296691	AU	40217/01	EP	1224666	WO	0122421
US	6593525	CA	2419170	GB	2389153	NL	1022844
US	6108202	CN	1177225	EP	0816177	JP	10023636
US	4129743						

END OF ANNEX